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DESTRUCTIVE FOREST INSECTS OF
YELLOWSTONE NATIONAL PARK

by

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Forest insects kill trees in three ways: by destroying the foliage, by destroying the inner bark of the main trunk, or by destroying the small rootlets. At the present time the important pests of the forests of the Yellowstone fall into the first two classes—defoliators and bark destroyers or girdlers.

The defoliators are again divided into those which destroy the foliage by biting and chewing it, and those that suck the sap until the needles die, turn brown and finally fall from the tree.

To fight the biting defoliators it is necessary to apply a stomach poison to the foliage, which they will take into the alimentary canal when they are eating the needles. To fight the sucking defoliators it is necessary to place in contact with them a smothering or burning substance while they are on the foliage. Either of these materials may be applied to the foliage in the form of a liquid spray or of a dust. Arsenate of lead is the stomach poison generally used, and sulphur, nicotine or petroleum oil the contact poison.

Both stomach and contact sprays have to be applied by the use of special machinery, such as sprayers, dusters, airplanes etc., which makes these methods of control expensive and applicable only to areas of special value, such as roadsides, camp sites etc.

The bark destroyers are fought by felling the infested trees and destroying the insects developing in the inner bark. Sometimes the tree is barked so that the broods die from exposure, sometimes the tree is burned, and sometimes it is placed where it will be exposed to the direct rays of the sun for from three to seven days and then turned. An air temperature of 80° will give a bark temperature of 110° to 120°, which will kill some of the more important girdlers in three hours' exposure.

The most important forest insects of the Yellowstone are three biting defoliators and five barkbeetles. The defoliators are the spruce budworm, Cacoecia fusiferana (Clemens), which has killed numerous Douglas firs near Camp Roosevelt, and the lodgepole sawfly, Neodiprion sp., and the lodgepole needletyer, Eulia sp., killers of many lodgepole pines near West Yellowstone. The five barkbeetles are the Douglas fir beetle (Dendroctonus pseudotsugae Hopk.), responsible for many of the budworm-defoliated Douglas firs near Camp Roosevelt as well as the death of healthy Douglas firs at Camp Roosevelt and Tower Falls; the mountain pine beetle (Dendroctonus monticolae Hopk.), killer of lodgepole pine and whitebark pine in the Sylvan Pass area, at Cub Creek

and at Dunraven Pass; the Engelmann spruce beetle (Dendroctonus engelmanni Hopk.), killer of many Engelmann spruce east of Yellowstone Lake; the fir beetle (Dryocotes confusus Sw.), killer of Alpine fir in the Sylvan Pass area, and the Oregon engraver beetle (Ips oregoni Eich.), which has caused the death of many lodgepole pines in the camp sites at Old Faithful, Thumb, Lake, Fishing Bridge, and on some of the geyser formation areas, such as the Mud Volcanoes and Roaring Mountain.

One sucking defoliator, the spruce gall aphid (Chermes cooleyi Gill.), caused considerable alarm in the spring of 1927. The foliage of many of the Douglas fir along the Madison and Gallatin Rivers turned brown and fell from the trees. So far as could be determined, the aphid was the cause of the trouble. The new foliage, however, came out in good condition, and it is not believed that any serious permanent damage resulted.

THE SPRUCE BUDWORM

The full-grown spruce budworm is a dark brown or reddish brown caterpillar, about an inch long, with a black head and marked with a number of light yellow tubercles. It lives in a loosely-constructed nest of chewed needles, webbed together in the opening buds of fir, Douglas fir, spruce and other coniferous trees. Very often it is seen hanging down from the tree on a long web.

About the tenth of July most of the caterpillars transform in the nests to reddish-brown mummy-like chrysalids three-fifths of an inch long. Seven to twelve days later each healthy chrysalis produces a gray or brown moth, mottled with darker brown patches, streaks and spots, and with a wing spread of about one inch.

Upon emerging the moths fly about on the foliage and from tree to tree. Mating soon takes place, and the female lays masses of eggs on the foliage. The eggs are pale green, oval and flattened. They are laid in overlapping rows, usually on the under sides of the needles. The eggs hatch in from ten to twelve days and each young caterpillar crawls to some protected place, such as under a scale of bark or an old cone, where it spins a small white hibernating cocoon and spends the winter in retirement.

In the spring, about the time that the new growth starts and the buds begin to open, the young caterpillars leave their hibernating cocoons and mine into the opening buds. Most of the needles in a bud are eaten off and the young twig is blighted. A single caterpillar may blight more than one bud. During an epidemic infestation they are in great numbers, all the new growth may be killed by the young caterpillars and all the older foliage destroyed by the feeding of the older caterpillars.

One year's complete defoliation will kill some trees, and three or four years' defoliation will kill most of them.

The application to the foliage of a poison spray or dust about the time the new buds are opening is the only method of control thought feasible for this pest.

THE LODGEPOLE SAWFLY

The adult female lodgepole sawfly is a small brownish wasp-like insect about 5/16 inch long, with a wing spread of three-quarters of an inch. The male is smaller and black, with many-branched antennae.

The sawflies emerge from the ground about the first of June and fly to the foliage of the trees when they mate. The female then lays her eggs in shoe-shaped pockets on the edge of a needle, two to eleven eggs to a needle. In about a month the eggs hatch out, and the young caterpillars mass together around a needle and start feeding on it.

In feeding, the caterpillars eat irregular patches of pulp from the outer surface. Sometimes they strip off the pulp completely leaving only the midrib. As they grow older they scatter somewhat and eat the entire needles down to the sheath. Most of the feeding is done on the older needles, but sawfly caterpillars will eat the new growth.

The full-grown caterpillar is smooth and of a greenish or greyish-green color marked by lighter stripes along the sides and the back. It is about an inch long and has a dark brown head with conspicuous black eyes. There are three pairs of true legs and eight pairs of fleshy false ones.

About the middle of September the caterpillars are full-grown and drop to the ground. As soon as each finds a suitable place under the top layer of old needles that cover the ground, it spins a tough brownish parchment-like cocoon around itself and shortens up into a dark-green, quiescent grub-like stage. In this stage it passes the winter, or even the second or third winter, before it transforms to a chrysalis-like pupa and then to a sawfly which emerges and flies to the foliage to mate and start a new generation.

During the period 1921-1925 the sawfly and the needletyer, working together, killed about 12,000 acres of lodgepole pine forest near West Yellowstone. The Park Service protected the trees along the highway between West Yellowstone and the Madison River Bridge by using an arsenical spray on the foliage during 1924, 1925, 1926 and 1927. The formula used was 25 pounds of powdered arsenate of lead and one gallon of fish oil to each 400 gallons of water, applied with a large power sprayer.

THE LODGEPOLE NEEDLETYER

The adult lodgepole needletyer is a small brownish-grey moth with a wing spread of three-eighths of an inch. Some time between the fifteenth of May and the first of July it emerges from a brown mummy-like chrysalis which has overwintered under the top layers of old needles on the ground in the forest. Soon after emergence the moth flies to the foliage of a lodgepole pine, mates, and the female lays a mass of from one to twenty-five flat oval slightly-corrugated light-green eggs on the concave side of a needle. Usually the eggs are laid overlapping one another in two alternating rows near the middle of a needle.

About nine days after they are laid the eggs hatch out and the young caterpillars crawl around over the foliage until they find a suitable needle. When a suitable needle--usually one of the new growth--is found, a hole is gnawed through the surface near the tip, and the interior is mined out for food and to form a protective tube for the insects.

In about two weeks the young caterpillar has eaten most of the needle's interior and has become too large for its home. It therefore sheds its skin, emerges from the needle, and drawing several surrounding needles to it webs them together to form a large tube. Within this web-lined tube it lives until full-grown, feeding on the surfaces of the needles, and enlarging its home as needed by drawing together more needles.

As soon as a caterpillar attains maturity, which is about the first of September, it drops to the ground by a long silken strand, crawls under the top layer of needles, finds a suitable place, webs together a few old needles or old cone scales and changes to the brown mummy-like chrysalis, in which stage it spends the winter.

When the caterpillars occur in epidemic form the leaf surface of many of the trees is almost completely destroyed by the end of August. Several years of this kind of defoliation will kill some trees.

Working in cooperation with the sawfly, the needletyer killed about 12,000 acres of lodgepole pine near West Yellowstone during the period 1921-1925.

The arsenate of lead spray is a good control for this species.

THE DOUGLAS FIR BEETLE

The Douglas fir beetle is the most important barkbeetle enemy of forest trees in Yellowstone Park. Hundreds of Douglas fir trees have been killed in the areas near Crescent Hill, Garnet Hill, Hell-roaring Mountain and along the Yellowstone River between Little Buffalo Creek and Blacktail Deer Creek. Small groups of trees have been killed at Camp Roosevelt and at Tower Falls.

The adult insect is a stout reddish to blackish brown cylindrical beetle about one-fifth of an inch long. The pupa (chrysalis) is about the same size as the beetle, white, and has the wings and legs folded on the chest. The top of the head is flattened. The larva (grub) is about three-tenths of an inch long when grown, and is white with a brown head.

Usually the winter is passed in the young-beetle stage under the bark of a dying tree. Sometimes a single beetle is found in a cell by itself; but more often the inner bark will be so completely mined out that a number of beetles are found together in a common chamber.

The young beetles emerge from their winter quarters during the period April to July and attack new trees. In budworm areas they attack the trees that are weakened by budworm defoliation; in other areas they attack trees weakened by fire or other injury, or even trees that appear perfectly healthy.

In attacking a tree the beetles start in a crevice in the bark of the main trunk, and gnaw a mine through the outer bark and nearly straight up through the inner bark for from eight to fourteen inches. The female beetle, as she gnaws her way along, deposits from 60 to 160 eggs in alternate groups along the sides of the mine.

The eggs hatch in about two weeks after they are laid and the young grubs start lateral mines of their own in the inner bark. Each grub (larva) makes its own mine, feeding and growing as it goes. The larval mine is narrow when it starts from the parent mine, but is broadened by the grub as it grows and mines along. Fully-developed larval mines are from three to six inches long.

By the first of August many of the grubs are full-grown and ready to start transforming to the pupal (chrysalis) and beetle stages. An enlargement of the end of the mine is made in the inner bark, and in this so-called pupal cell the transformation to beetle takes place.

The young beetles mine through the inner bark until most of it is destroyed. Some may emerge from the tree in the fall, but most of them remain under the bark until the next spring.

Trees infested by the Douglas fir beetle are indicated by the reddish boring dust lodged in the crevices of the bark and on the ground at the base, and by the yellowing or reddening of the foliage.

Control consists of felling and barking or felling and burning the infested trees before April first of the year following the attack.

THE MOUNTAIN PINE BEETLE

The mountain pine beetle attacks and kills all species of pines that occur in the Yellowstone. It is a destructive enemy of the lodgepole throughout most of its range, and has killed nearly all the mature trees on large areas in the Yosemite and the Crater Lake. During the last few years it has killed numerous lodgepole and whitebark pines at Cub Creek, and whitebark pines at Dunraven Pass.

The adult insect is a black cylindrical barkbeetle about one-fifth of an inch long. The pupa (chrysalis) is about the same size as the beetle, but is white and has the legs and wings folded on the chest. The top of the head is deeply grooved, and there are two prominent forward-curved spines in front. The larva (grub) is about three-tenths of an inch long when grown, and is white with a brownish head. The front is marked by a prominent transverse rugose elevation.

The winter is passed as parent beetles, larvae or young beetles in the inner bark of dying trees. In July the young beetles start to leave the dying trees and attack new ones. The emergence and attack continues into September or October, though most of the attacks are probably made in August. Fire-scorched and otherwise injured trees are attacked in many cases, but often thousands of perfectly healthy trees are killed.

Usually the attack starts in a crevice of the bark of the main trunk. A tunnel from twelve to thirty-six inches long is gnawed nearly straight up through the inner bark by the parent beetle. The eggs are laid in small niches in the sides of the tunnel. The entrances to most of the tunnels are marked on the outer bark by masses of resin mixed with boring dust, the "pitch tubes".

The eggs hatch in from ten to fourteen days after they are laid, and the young grubs start lateral mines in the inner bark. A few grubs become full-grown in from sixty to ninety days, and transform to pupae and then to beetles; but most of the brood does not mature until June of the following year. The larval mines are from two to three inches long and each terminates in an enlargement, the pupal cell, within which the transformation to pupae and beetles takes place.

The combined boring of the parent beetles and the larvae completely kills the inner bark of the trees attacked, and by fall they start dying. Some turn red, but many remain green until the following July.

Trees infested with the mountain pine beetle are indicated by the reddish boring dust lodged in the crevices of the bark and on the ground at the base, by the "pitch tubes" on the bark, and by the yellowing or reddening of the foliage.

Control consists of felling and burning the infested trees, or felling and placing them in the sun for several days and then turning them. An air temperature of 80° F. for three hours will give a killing bark temperature of 110°-115°.

THE ENGELMANN SPRUCE BEETLE

The Engelmann spruce beetle looks and lives very much like the Douglas fir beetle. The beetle is usually broader and dark, and the larva bears a pair of plates on the back of the last two segments. The tunnels under the bark are usually shorter.

Both Engelmann spruce and blue spruce are attacked and killed. Numerous mature Engelmann spruce have been killed during the last few years on Frank Island and in the forests east of Yellowstone Lake. A few infested trees were found in 1926 at the Grayling Creek snowshoe cabin, near the northwestern boundary of the Park.

The species overwinter as larvae and young beetles in the inner bark of trees attacked during the preceding summer. Development is completed and the young beetles emerge and attack new trees during June or July.

The first evidence of an attack by this species is the reddish boring dust in the crevices of the bark and on the ground. Later the needles fade slightly and fall to the ground. Often woodpecker work shows on the bark.

Control consists of felling the infested tree and barking it before May first of the year following the attack.

THE FIR BEETLE

The fir beetle is about three-sixteenths of an inch long, cylindrical, slender, dark brown or blackish in color, and clothed with reddish hairs when viewed under the microscope. It attacks and kills the alpine fir in various sections of the Park. In 1926 a number of trees were killed in the Sylvan Pass section.

The species overwinters in the inner bark in the larval and young-beetle stage. Emergence and attack on new trees takes place in the spring. The tunnels made by the parent beetles curve considerably and often extend horizontally instead of straight up the trunk like the Douglas fir beetle, mountain pine beetle and Engelmann spruce beetle. The eggs are laid in niches along the sides of the tunnel, and the larval mines wind irregularly through the inner bark.

An infestation is indicated by the boring dust on the bark and the yellowing or reddening of the foliage in September and later.

Control consists of felling the infested trees in the spring and burning or barking them.

THE OREGON ENGRAVER BEETLE

One of the most important forest insect problems in the Yellowstone is the protection of the trees in the various camp areas. Such trees are growing under the more or less unnatural conditions caused by the various activities of many more or less irresponsible human beings. The soil over the roots becomes packed, causing a lack of proper aeration, and the bark of the main trunk is injured by the scorching of many camp fires, by nail holes, ax cuts, scraping of automobiles and in various other ways.

The creation of unnatural conditions in any forested area usually leads to a concentration in the area of the insects that normally live in the broken tops, branches and wind-fallen trees which are scattered throughout the surrounding forest.

The hot water overflows and other activities around the geyser formations also create unnatural conditions and a similar concentration of injurious forest insects.

Probably the most important insect enemy of the trees in the camp and geyser-formation areas of the Yellowstone is the Oregon engraver beetle.

The beetle is about three-sixteenths of an inch long, blackish or reddish brown in color, cylindrical, with the rear end excavated and marked by four teeth on each side of the excavation. The larvae are small white grubs with brown heads. The pupae are shiny, white, and about the same size as the beetles. All stages are found in the inner bark of the main trunk of dying trees.

In the Yellowstone there are two generations of the Oregon engraver beetle each year. Beetles from the overwintering generation emerge from the dying trees during the last of June, attack new trees and lay eggs which develop into the second generation. Beetles from the second generation emerge the last of August from the trees they have killed, attack new trees and lay eggs which develop into the overwintering generation of the following year.

The Oregon engraver beetle in attacking a tree usually starts in a crevice of the bark and gnaws through the outer bark down into the inner bark, where it hollows out a small chamber. From this three to five female beetles gnaw separate tunnels, which radiate out in all directions from three to six inches through the inner bark. The eggs are laid along the sides of these tunnels in separate niches. Each grub forms a separate mine through the inner bark. This mine is from one to three inches long and gradually becomes wider as the grub grows. The mine terminates in a small cell or enlarged portion in which the grub transforms to the pupal and beetle stages.

Infested trees are indicated by the red boring dust in the crevices of the bark and on the ground at the base of the tree, and by the yellowing or reddening of the foliage.

Control consists of felling and burning the infested trees during the late fall or spring.

THE SPRUCE GALL APHID

The spruce gall aphid is a small, dark, scale-like sucking insect which spends the winter resting upon the upper surface of a Douglas fir needle. In the spring, as soon as the weather becomes warm, it starts to grow, sheds its skin and throws out a protective covering of long curled threads of a white secretion that resembles wool. About the first of May, twenty-five to forty light-yellow eggs are laid under the woolly covering. These hatch when the new growth of the tree starts and the young crawlers move out on the new needles, insert their beaks into the tender growth and commence to feed and grow. It is the sucking of the sap in feeding that injures the needle, and if the insects are sufficiently numerous causes it to turn brown, die and finally fall from the tree.

As soon as the aphids are full-grown, they lay eggs as their parents did. These eggs soon hatch, and the young insert their beaks into the needles, take on a dark color, secrete a little "wool" about themselves, and so remain until the following spring before growing and becoming adult.

Certain individuals of the spring generation develop wings and fly away to the Engelmann spruce, where they lay their eggs on the needles. The young hatching from these crawl to the developing buds of the spruce and settle at the bases of the young needles and feed. The irritation of this feeding causes an abnormal growth of the bud, which forms a cone-like gall in which a new generation of insects develop. The gall thus formed gives the insect the name of the spruce gall aphid.

Control consists of spraying the foliage of the infested trees in the early spring with a solution of ten gallons of miscible oil and two quarts of forty per cent nicotine sulphate to four hundred gallons of water.

While this insect caused considerable alarm in the spring of 1927 because of the browning of the foliage of many Douglas fir along the Madison and Gallatin Rivers, it is usually not considered an important forest insect. Often, however, Engelmann spruce trees are covered with the cone-like galls and look rather ragged.